An Assessment of Nuclear Materials Disposition Orphans at the Fernald Site

Nonactinide Isotopes and Sealed Sources Management Group

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1 Introduction

EM-1 has defined nine "Key EM Goals/Priorities" for the Department of Energy Environmental Management (EM) [DOE, 2001]. As part of the support for Goal 3, Close Rocky Flats, Fernald, and Mound by 2006, EM-21, the Office Nuclear Materials and Spent Fuel, tasked the Nonactinide Isotopes and Sealed Sources Management Group (NISSMG) to lead a comprehensive assessment of disposition options for nuclear materials disposition orphans at the Fernald Site. The NISSMG performed this evaluation with assistance from the Uranium Management Group (UMG), Nuclear Material Focus Area (NMFA), and site personnel.

2 Purpose

The purpose of this evaluation is to identify all orphan nuclear materials that have no disposition path. Materials with disposition paths or end-states can also be defined as orphans due to not meeting regulatory requirements, processing needs or even shipping constraints. Once the issues associated with the nuclear materials were understood and evaluated recommendations were provided for the disposition. In addition, materials that have defined disposition paths were reviewed to verify the continuing viability of those existing disposition paths and to determine if there may be alternatives that may reduce cost or provide reuse applications, and where there is a clear benefit to Fernald or DOE.

Fernald has material in inventory that must be dispositioned prior to site closure. As facilities are decommissioned, processing, packaging and shipping capabilities are reduced at the site. Closure sites are continuously reevaluating and changing decommissioning and closure activities in an effort to improve on current closure schedules and resolve imminent issues identified during the closure process. The material disposition plans established for Fernald must also be reevaluated on a regular basis to maintain consistency with site closure plans to ensure that changes impacting material disposition are identified and addressed. Capabilities required to implement the disposition plans must be identified as part of the ongoing reevaluation process.

3 Background

3.1 Fernald's Mission

After World War II, the Atomic Energy Commission (AEC) built government owned uranium refineries in Fernald, Ohio, (the Feed Material Production Center (FMPC)) and in Weldon Spring, Missouri. FMPC, also known as the Fernald Environmental Management Project, opened in 1952 for fabrication of fuel and targets and began uranium sampling in the mid

1950's. The Fernald uranium refinery closed in 1972 although processing of recycled uranium continued until 1989.

3.2 Background

When production activities ceased at the Fernald Site in mid-1989, there remained in inventory 13,670 metric tons uranium (MTU) in many forms and enrichments. Since that time, there has been an ongoing effort to disposition those materials appropriately.

If accomplishments were to be measured from shutdown in mid-1989, then over 10,000 MTU, or 25 million net pounds, have been shipped off the Fernald Site, including return of feed to suppliers. Some of the materials were able to be written-off by applying the economic discard limit or declaring the material to be . These materials are not included in the 10,000 MTU cited in these accomplishments.

Since Fluor was awarded the contract to operate the Fernald Site in 1992, over 8,000 MTU of nuclear materials from product inventories remaining after site shutdown have been shipped off-site. In general, the disposition paths for those materials were: 1) relocation of material for programmatic use, 2) sales to private sector customers to get the materials back into the commercial fuel cycle or for other commercial applications, and 3) burial of classified Army-owned materials. These paths were in accordance with the DOE-HQ document "Transfer of the Feed Materials Production Center [DOE, 1990]." This involved over 800 shipments, over 12,000 Department of Transportation packages, thousands of inner containers, and approximately 100,000 pieces of uranium metal and drums of uranium compounds, weighing a total of over 20 million net pounds. All of this was accomplished without any major incident or injury to personnel, while meeting internal and external commitments, except where circumstances were beyond the site's control (for example, complex-wide moratoriums on shipments for various reasons).

Noted below are the materials yet to be shipped and the planned disposition paths.

Table 1: Product Disposition

Description	MTU *	Current Containers **	Disposition
Enriched Compounds	81	763	Portsmouth
Enriched Metal	38	622	Portsmouth
Enriched Metal	76	435	Private Sector Sale
Reject Product ***	171	1755	Uranium Waste

*MTU – metric tons uranium weight.
** This number fluctuates daily due to repackaging and shipping activities. At any given time, it may include containers as the materials had been stored and as repackaged containers prepared for shipment.
*** Includes depleted, normal and enriched compounds and metal that will be dispositioned through the appropriate Uranium Waste Disposition (UWD) stream after waste declaration (for purposes of this document, the quantities are included in the UWD streams).

Table 2: Uranium Waste Disposition

Description	MTU *	Current Containers or Items **	Disposition
Fissile Compounds	122	2094	To Envirocare thru the Waste Materials Processing System (WMPS)
Fissile Excepted and <1% ^{235}U Compounds	314	3911	To Nevada Test Site (NTS)
Fissile Excepted and Depleted Metals	399	806	To NTS
Fissile Metal	150	664	To Recovery Option
RCRA Compounds	18	368	To Envirocare thru WMPS or to NTS as appropriate after recharacterization

*MTU – metric tons uranium weight.
** This number fluctuates daily due to repackaging and shipping activities. At any given time, it may include containers as the materials had been stored and as repackaged containers prepared for shipment.
*** Includes depleted, normal and enriched compounds and metal that will be dispositioned through the appropriate Uranium Waste Disposition (UWD) stream after waste declaration (for purposes of this document, the quantities are included in the UWD streams).

3.3 Sealed Sources at the Fernald Site

Sealed sources had various uses at the Fernald Site including instrument calibration source checks, level gauges, moisture density gauges, soil compaction gauges, and laboratory detection and calibration equipment. However, with the cessation of operations at the site, there are hundreds of excess sealed sources in the inventory.

The Fernald Site completed a site-wide inventory and assessment of nonactinide isotopes and sealed sources (NISS) in June 2000. The inventory revealed that there were 622 NISS material items at Fernald. Since then, two have been added for a total of 624. Of that number, 26 are actively in use. In accordance with 10 CFR 835, the accountable sources are inventoried every six months (126 of the 624 are accountable). Whether currently excess or in use, the items have been divided into eight (8) material streams for disposal purposes based on radiation and chemical characteristics, consistent with NISS Material Management Plan (MMP) methodology. Those eight streams are listed in the table 3, as well as the number of items and recommended disposal paths for each stream.

Table 3:

Description	Items	Disposition Path
1. Actinide Sources (U-238, Th-228, Th-230, Th-232)	288	LLW at NTS

Description	Items	Disposition Path
2. Actinide Sources (Am-241)	56	TRU Waste at WIPP
3. Neutron Sources (Am-241/Be	2	TRU Waste at WIPP
4. Orphans Am-241/Be Neutron source Radium 226 Source Cesium 137 Source	 1 1 1	 TRU Waste at WIPP Commercial LLW LLW at NTS
5. Accountable (No Radium)	102	LLW at NTS
6. Exempt (No Radium)	122	LLW at NTS
7. Accountable (Radium)	1	Commercial LLW
8. Exempt (Radium)	50	Commercial LLW
Total Sealed Sources	624	
Liquid Technical Standards	25 Liters	LLW at NTS

3.4 Previous Fernald Disposition Planning

On January 20, 1998, the DOE Office of the Deputy Assistant Secretary for Nuclear Material and Facility Stabilization (then DOE/EM-60) initiated the Nuclear Material Integration (NMI) Project [Kiess, 2000]. The goals of the NMI Project were to inventory and analyze the nuclear materials in the DOE Complex. The scope of this project included not only materials owned by EM but also those owned by other programs and stored in EM facilities. In addition, materials expected to transfer to EM ownership by 2015 were to be considered. The purpose of the analysis was to support both risk and mortgage reduction efforts in the complex and to make recommendations for material management and disposition. The ultimate goal of this effort was to develop a comprehensive nuclear material management plan for the complex in support of EM's accelerated cleanup vision.

Four teams were formed to implement the NMI Project. Three material management teams were responsible for the different groups of materials in the DOE Complex:

- Transuranic (TRU) Team, responsible for most transuranic elements
- Uranium/Thorium Team, responsible for most uranium and thorium materials
- NISS Team, responsible for all radioactive isotopes with an atomic number less than 90 and all sealed sources, irrespective of atomic number.

The fourth team formed was the Integration Team, which had responsibility for overall project direction and coordination among the material teams. As a part of the NMI project, the NISS Team visited the Fernald Site April 1998. These meetings, and subsequent interactions with the site, resulted in the development of a set of baseline nuclear materials disposition maps. These disposition maps [DOE, 1999] were first published in March 1999 and identified 24 nuclear

material streams for the Fernald Site. At that time, 10 of those streams were identified as having a To Be Determined (TBD) disposition path.

Since that time the material management teams and their successor organization, the material management groups, have worked with the Fernald Site to resolve nuclear material management and disposition problems. As an example, the Nonactinide Isotopes and Sealed Sources Management Group (NISSMG) issued a report in September 2000 [NISSMG, 2000] that developed disposition paths for all sealed source materials at the site.

The NISS items at Fernald were offered (through the DOE excess property system) as excess in 2001. Only two interests were expressed for a total of less than 20 items. The Property Disposition Supervisor for Fluor has deemed the other items as "scrap" and released them for appropriate disposition.

In December 2001, coordinated with the timing of the semi-annual inventory of the accountable sources, the various types of sources were photographed and logged by source number in preparation for disposition.

The Nuclear Materials Focus Area has also supported Fernald through development of technologies to support disposition including:

- Vacuum Transfer System – This system is being used to speed repackaging of product nuclear materials while reducing worker exposure [Kaushiva, 2002]
- Waste Materials Processing System – This system is developing an alternative process to disposition the enriched restricted materials
- Gubka Demonstration – The use of this Russian technology to stabilize liquid technical standards has addressed an entire class of problematic nuclear materials at the site [Knecht, 2002]

The demonstration of Gupka has now progressed to a deployed technology. The complete inventory of liquid technical materials is now in the final stages of treatment and will be shipped to NTS for disposal as LLW in March/April of this year.

The Uranium Management Group (UMG) has also been supporting Fernald since 1999 in the disposition of the their excess materials, this support is evident in the current baseline planning for the reuse of fissile material as part of the "Alternate Feed Program [UMG, 2001]."

In June 1999, Fernald Site began shipping product materials to the Interim Storage Facility at the Portsmouth site. The product materials milestone will be accomplished as committed. Furthermore, Fernald Site has embarked upon a program that is intended to provide a disposition path for ~150 metric tons of uranium (MTU) of remaining waste materials and allow for its reuse in the commercial nuclear fuel cycle. This effort has been named the "Alternate Feed Project."

4 Methodology

The methodology used in defining final disposition paths for the remaining orphan materials at Fernald includes reviewing existing data, identifying the orphan materials, identifying unique characteristics of the material, evaluating reuse and disposal alternatives, selecting a recommended alternative, validating that the material is viable for the recommended alternative, and finally, facilitating disposition of the material.

- Review Existing Data – The NISSMG team reviewed the IPABS database, previous NISSMG management disposition plans, and local site database information.
- Identify Orphan Materials – Orphan materials are those items that have no defined disposition path. Each stream was evaluated to identify the hard to disposition items. In addition, during the review of the data, the NISSMG team elicited additional information to determine if there are items or streams that may not have been captured in the previous investigations.
- Identifying Material Characteristics – Each item that is identified as a potential orphan is discussed in detail to define qualitatively the characteristics. Where analytical data is available, it is reviewed to support the material disposition determination. This function supports the selection of potential disposition alternatives.
- Reuse and Disposal Alternatives – Based on the material characteristics, reuse applications are evaluated first. Where feasible, material is returned for use within the DOE Complex. Reuse alternatives are evaluated to ensure that the application can be accomplished within the schedule constraints of the closure site. The NISSMG team is knowledgeable of the disposal requirements at Hanford, NTS, and Envirocare and is also aware of treatment and processing capabilities required prior to disposal.
- Recommended Alternative – In consideration of material characterization data, site schedules, processing capabilities, and reapplication feasibility, a recommended alternative is selected.
- Alternative Validation – The validation of the alternative occurs after the NISSMG team communicates with the receiving site. NISSMG provides the characterization data and material information to the receiving site and facilitates the receipt of additional information where required.
- Material Disposition – The final step in the process is the disposition of the material. NISSMG facilitates the disposition as needed to support the closure site and receiving site requirements. This effort can range from simple logistical support through identification of shipping containers and detailed transportation and packaging analysis to support DOE and DOT requirements.

Following the above methodology provides the structured rigor necessary to facilitate material disposition within the highly regulated radioactive and hazardous material environment.

5 Management Disposition Plans

Following the disposition methodology, the NISSMG team utilized the baseline material disposition maps as the foundation for this analysis to determine potential impacts associated with orphan materials. Detailed meetings were held at Fernald on January 8, 2002 and each disposition map was reviewed and discussed in detail to identify all of the information available for each disposition map. Fernald personnel provided current database information where available and provided additional detail on each stream through elicitation of information by the NISSMG Team. The following material disposition maps for Fernald present the current baseline and identify recommended disposition paths for all items based on the information received from the site, knowledge of reuse and reapplication opportunities, knowledge of current onsite processing capabilities and knowledge of waste disposal requirements.

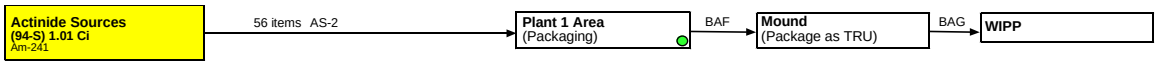
There is only one material stream at Fernald currently defined as orphan nuclear material. This stream (Am-241) has a defined end state (TRU Waste) but Fernald is not a WIPP certified disposal site and is unable to utilize this disposal path. Two additional streams (Fissile Compounds and Fissile Metals) have viable disposition paths but represent opportunities for major cost savings if an exemption to regulatory shipping requirements can be obtained and criticality issues for disposal as LLW can resolved.

5.1 Americium – 241

There are two direct disposal options for the Fernald Site Am-241 sources and it is recommended that those sources that meet the NTS WAC be disposed of as LLW, and those sources which are categorized as TRU waste be transferred to the Mound TRU program for disposal.

Historical costs for disposal of actinide sources as LLW is in the $100-$150 per source range which provides for the waste profiling and for source packaging. Shipping and NTS disposal cost would also need to be added. While WIPP does not charge a fee for emplacement or transportation, historical costs for establishing a TRU Waste certification program meeting the WIPP criteria can exceed $1M. Characterization to meet the WIPP WAC for each drum typically costs ~$50K. Clearly, these costs drive the recommendation to utilize an existing TRU waste program. Mound has an established program and is positioned to support the disposition of this material.

Recommendation: Transfer these 56 items to the Mound TRU Program and dispose as TRU waste.

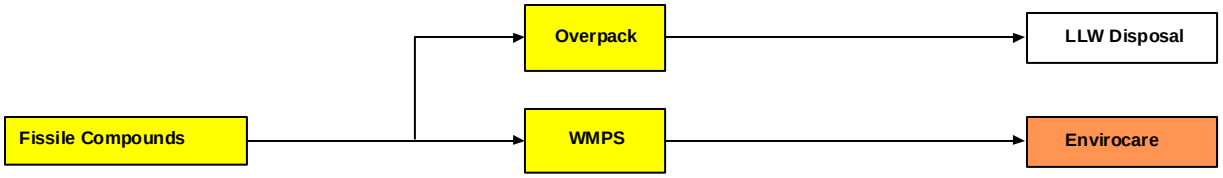


5.2 Fissile Compounds

Fernald has ~122 MTU classified as "Fissile Compounds". Baseline planning for this material is disposal at Envirocare after processing through the Waste Materials Processing System (WMPS) facility. In the WMPS facility the material will be characterized, resized, blended with Waste Pit Remedial Action Project (WPRAP) soils and repackaged to meet the standards for shipment as fissile exempted material under 49CFR173. The project to develop the WMPS is currently jointly funded by the Fernald Site and the Nuclear Materials Focus Area and is scheduled to begin operations in February 2003.

An alternate approach for disposition of this materials group would be to get an exception to the DOT fissile material packaging requirements and obtain disposal site acceptance for direct disposal of enriched material. Given the low enrichment of this material (93 % is <1.25% & 7% is between 1.25 and 5%), it should be possible to do a criticality analysis to show it could be shipped and disposed of safely without repackaging. Although this would eliminate the need for resizing and blending of materials, they would need to be overpacked in new containers.

Recommendation: Continue to pursue development of the Waste Materials Processing System. Initiate a parallel effort to gain DOT exemptions and disposal site acceptance of direct disposal of this material.

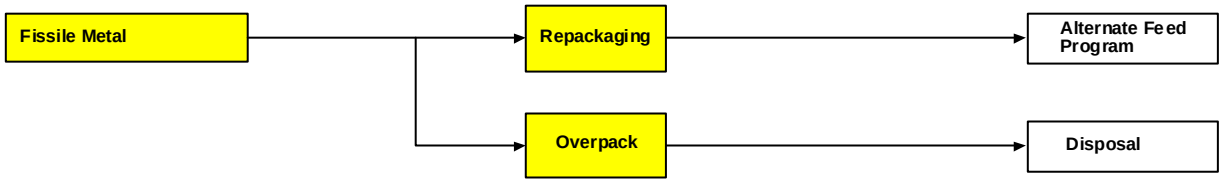


5.3 Fissile Metal

Fernald has ~ 150 MTU classified as "Fissile Metal". Current baseline planning for this material is to ship it to Nuclear Fuel Services (NFS) in Erwin, TN, for storage and subsequent processing for beneficial reuse in the nuclear fuel cycle as part of the Alternate Feed Program. The recycling effort will be coordinated by the Uranium Management Group (UMG) at Oak Ridge. The UMG is currently accepting and managing the disposition of uranium product materials from Fernald Site, and this recycling of material would be a continuation of UMG scope for use of excess DOE uranium materials. NFS has extensive experience process materials for defense purpose and for use in the commercial nuclear fuel cycle and is currently performing bench scale testing on Fernald materials to explore recycling. A proposed pilot facility could potentially process all of the Fernald fissile metals, and it would also provide engineering and operational data for possible future construction of a large scale treatment facility to process the very large volumes of uranium materials from throughout the DOE complex.

An alternate approach for disposition of the fissile metals would be to get an exemption to the DOT fissile material packaging requirements and gain disposal site acceptance for direct disposal of the enriched material at NTS or Hanford. Given the low enrichment (<3.03% ^{235}U) of this material, it should be possible to do a criticality analysis to show it could be shipped and disposed of safely without size reduction or other processing.

Recommendation: Continue to pursue recycle of this material through the UMG Alternate Feed Program. Initiate a parallel effort to gain DOT exemptions and disposal site acceptance of direct disposal of this material.



6 Recommendations

The above material management disposition plan identifies the material issues that are considered in determining recommended disposition paths. These issues have been considered and the following recommendations are made for this path. In addition, the clear benefit derived from the recommended disposition path is included to support the selection of the recommended alternative.

Material Stream	Recommendations	Benefit
Am241/Be	Transfer the material to the Mound TRU program for disposal at WIPP via SRS.	The disposition of the material through a transfer to the Mound TRU program for shipment to SRS provides the most expedient means of dispositioning this material. In addition, this path has been proven viable through the disposition of Mound material in FY01.
Fissile Compounds	Continue to pursue development of the WMPS and initiate a parallel effort to gain DOE exemptions and disposal site acceptance for direct disposal.	Eliminating repackaging and blending operations reduces cost, meets ALARA requirements, and provides the most direct approach to disposition of this material.
Fissile Metals	Continue to pursue recycle of this material through the UMG Alternate Feed Program. Initiate a parallel effort to gain DOT exemptions and disposal site acceptance of direct disposal of this material	Eliminating repackaging and resizing operations reduces cost, meets ALARA requirements, and provides the most direct approach to disposition of this material.

7 Conclusion

All of the material identified in the management disposition plan has a feasible baseline disposition path for removal of the material from Fernald. There are no new technologies or packaging systems that require development to facilitate this material disposition activity. It is not intended to imply that the disposition process will be simple. There will be difficulties and technical issues associated with some of the disposition paths but with adequate funding and personnel resources these details can be managed consistent with site closure requirements.

Finally, it is imperative that Fernald and NISSMG maintain communication to address issues that arise through the identification of new materials requiring disposition, identification of characterization information that inhibits the recommended disposition path, and changes in site capabilities that may impact the ability to characterize, package, and transport materials. NISSMG is available to facilitate support of the ever-changing conditions of closure sites.

8 Path Forward

The path forward for the disposition of material should link directly with the closure activities and schedule for Fernald. The materials have been determined to have feasible disposition end states, thus the path forward should lead to complete disposition with no impact to site closure schedules. In order to minimize programmatic risks of material disposition, the following should be implemented:

- Proceed with recommendations on material disposition included in this evaluation.
- Consider utilizing the NISSMG in evaluation and disposition of radioactive waste streams at Fernald.
- Maintain communications with the NISSMG to support expedient disposition of new materials that may be located or identified during facility closure activities.
- Evaluate material disposition activities at least quarterly to determine if modifications to disposition paths are necessary as changes in facility capabilities or disposal requirements are identified.

9 References

DOE, 1990 "Transfer of the Feed Materials Production Center," DOE-HQ, October 1990.

DOE, 1999 "NM Stewardship Program - Predecisional Draft Nuclear Material Disposition Maps by Site," March 1999.


DOE, 2001 "Environmental Management Priorities," Memorandum from Jessie Hill Roberson, EM-1, November 19, 2001.

Kaushiva, 2002 "Fernald Vacuum Transfer System for Uranium Materials Repackaging," Shirley Kaushiva, et. al., Waste Management '02, Tucson, AZ, February 24-28, 2002.

Kiess, 2000 "Nuclear Materials Management in the Environmental Management Program," Thomas Kiess, et. al., Spectrum 2000, International Conference on Nuclear and Hazardous Waste Management, Chattanooga, TN, September 24-28, 2000.

Knecht, 2002 "Deployment of Porous Crystalline Matrix (Gubka) Technology for Stabilizing Radioactive Standard Solutions at Fernald," D. A. Knecht, et. al., Waste Management '02, Tucson, AZ, February 24-28, 2002.

NISSMG, 2000 "Fernald Sealed Source Disposal Plan," Nonactinide Isotopes and Sealed Sources Management Group, September 2000.

UMG, 2001 "Alternate Feed Project," Uranium Management Group, Oak Ridge Operations, 2001.